# COMBUSTION STOPPER SEAL

This invention relates to combustion stopper seals for cylinder head gaskets of vehicle engines and a method of making the same.

## Background of the Invention

Metal gaskets are well known for providing a seal between a cylinder head and a cylinder block of a motor vehicle engine. Typically these gaskets are formed with apertures over the combustion openings of the cylinders, and some gaskets have special sealing elements around the apertures to increase their sealing effectiveness. Such sealing elements may be formed by folding back an annular portion of the gasket about a circular fold line and pressing it against the main body of the gasket to form a stopper seal.

One of the problems associated with stopper seals is an uneven distribution of compression loading around the aperture. It has been discovered that the greatest load on the stopper seal is at or near the bolt-locations, that is, in the areas adjacent to the bolts which typically secure the gasket to the engine block. It is estimated that as much as 65% of the load is concentrated at the bolt-locations.

There are difficulties in sealing the combustion opening of an operating engine which arise from dynamic motion of the engine parts caused by operating conditions such as firing pressures and thermal gradients, for example, as well as parts design and material selection. To overcome these difficulties, it would be highly desirable to provide a stopper seal wherein the load is more evenly distributed and thus the sealing effectiveness is materially increased.

## Summary of the Invention

In accordance with the present invention, the gasket has an annular flange around the aperture to provide a stopper seal. The flange has spaced areas of varying thickness. Preferably the flange is a folded-over portion of the gasket plate and the areas of reduced thickness are adjacent to the bolt-receiving holes. By thus reducing the thickness of the flange adjacent to the bolt-holes where loading tends to be concentrated, it is possible to spread the loading so that it is more evenly distributed.

In accordance with a preferred method of the invention, an opening is formed in a gasket plate radially inwardly of an annular array of bolt-holes. The opening is non-circular and has edges adjacent to the bolt-holes which are spaced radially outwardly of a center point of the opening a greater distance than the intervening edges. An annular portion of the plate surrounding the opening is folded back about a circular fold line to form a flange which is placed in surface-to-surface contact with an underlying portion of the plate adjacent to the fold line such that the edges of the flange face radially outwardly. The flange is then compressed. Compression of the flange will result in areas of the flange adjacent to the bolt-holes, being compressed a greater amount, and hence be of lesser thickness, than the other areas of the flange more remote from the bolt-holes. This is due to the fact that the areas of the flange adjacent to the bolt-holes are of lesser radial extent and therefore have less resistance to forces of compression. The flange thus formed serves as a stopper seal for the gasket.

One object of this invention is to provide a gasket and gasket-making method having the foregoing features and capabilities.

Other objects, features, and advantages will become apparent as the following description proceeds, especially when considered with the accompanying drawings.

## Brief Description of the Drawings

Figure 1A is an view showing an initial step in the method of this invention in which an opening is punched in a gasket plate.

Figure 1B is a sectional view of the gasket plate after the opening has been punched.

Figure 2 is a plan view of the punched gasket plate.

Figure 3 is a perspective view of the punched gasket plate.

Figure 4A is a view of a second step in the method in which an annular flange is punched around the opening in the gasket plate.

Figure 4B is an edge view of the gasket plate showing the flange thus formed.

Figure 5 is a plan view of the gasket plate shown in Figure 4B.

Figure 6 is a perspective view of the gasket plate shown in Figure 4B.

Figure 7A is a view showing a third step in the method in which the annular flange is folded radially outwardly and doubled over against the main body portion of the gasket plate.

Figure 7B is a sectional view showing the gasket plate with the outwardly folded annular flange pressed flat against the main body of the gasket plate.

Figure 7C is an edge view of the gasket plate as shown in Figure 7B.

Figure 8 is a plan view of the gasket plate as shown in Figure 7C.

Figure 9 is a perspective view of the gasket plate.

Figure 10A is a view showing the annular flange being compressed against the main body of the gasket plate.

Figure 10B is a sectional view showing the gasket plate after the compression of the annular flange, completing the formation of the gasket of this invention.

Figure 10C is an edge view of the gasket plate shown in Figure 10B.

Figure 11 is a plan view of the gasket.

Figure 12 is a perspective view of the gasket.

**Detailed Description of the Preferred Embodiments**

Referring now more particularly to the drawings, Figures 1A-10A illustrate a sequence of steps in the method of making the finished gasket 20 shown in Figures 10B-12. The gasket 20 is formed from a flat plate 22 of suitable material such as, for example, tin plated, low carbon steel and have a uniform thickness which may be about .015 inches.

Referring to Figures 1A-3, the plate 22 is initially blanked by a punch 23 moving vertically or perpendicularly relative to the plate 22 to form a non-circular opening 24 having a center point 26. The opening 24 has four equally, angularly, spaced apart convexly curved edge portions 28 which are spaced from the center 26 a distance R1. Between and separating the curved portions 28 are the curved portions 30 which are spaced from the center 26 a lesser distance R2. The shape and form of the opening is greatly exaggerated in Figures 2 and 3 to illustrate the difference in radius of the two curved portions 28 and 30. In point of fact, the difference in these distances is relatively small. Thus, for example, the distance R2 may be .5% to 3% less than R1 depending upon the particular application.

An array of bolt-holes 32 surrounding the opening 24 may be formed in the plate 22 either before or after the opening 24 is punched. It is noted that the relatively large diameter edge portions 28 of the opening 24 are located adjacent to the respective bolt-holes 32.

The next step in the formation of the gasket is a forming operation shown in Figures 4A-6 and employing a cylindrical punch 34. The punch 34 is of uniform circular cross-section and of larger diameter than the maximum diameter of the opening 24. The punch 34 is centered on the opening 24 and moves vertically or perpendicularly relative to the plate 22 to form a tubular, annular flange 36 which extends perpendicular to the plane of the plate. The flange 36 is circular and its outer edge portion 38 is wavy, reflecting the initial form of the edge portions 28 and 30 of the non-circular opening 24.

Thereafter the flange 36 is folded back in a closing operation. As seen in Figure 7A, a frusto-conical folding tool 40 is centered on the annular flange 36 and is moved perpendicularly to the plate 22 to engage the flange 36 and fold it back or radially outwardly about a center fold line 42 into surface-to-surface contact with the underlying annular portion of the plate 22 adjacent to the fold line such that the edge portions 28 and 30 face radially outwardly and the flange is connected to the underlying portion of the plate 22 by a doubled-over portion 46 of the plate. The fold line 42 defines the marginal edge of an aperture 48 which will extend across a combustion opening of a cylinder when the gasket is in use. The folded over flange can be seen clearly in Figures 8 and 9, and again, it should be pointed out that the difference in radial extent of the edge portions 28 and 30 is greatly exaggerated in these Figures.

Finally, the flange 36 and the underlying annular portion of the plate 22 are compressed between the platens 50 and 52 which close perpendicularly on the plate 22 as shown in Figure 10A. The compressed flange 36 thus becomes a stopper seal 60. Figures 10B-12 illustrate the compressed and flattened condition of the flange after compression. There will be a difference in thickness of the flange around its perimeter as shown in Figures 10B and 10C, the flange being thinner along the edge portions 28 than along the edge portions 30. Thus the thickness T1 in the areas along the edge portions 28 may be on the order of about 0.0035 inches, whereas the thickness T2 in the areas along the edge portions 30 may be on the order of about 0.0045 inches. These dimensions may

vary. The thinner portions of the flange, it will be noted, are in areas adjacent to the bolt-holes 32.

The portions of the flange along the edge portions 28 adjacent to the bolt-holes is thinner than the portions along the edge portions 30 because the portions along the edge portions 28 have a lesser radial extent and hence offer less resistance to compression.

By forming the annular flange to a lesser thickness in the areas of the bolt-holes 32, it has been found that the distribution of loading forces on the flange when the gasket is bolted to the cylinder block is more evenly distributed than would be the case if the flange were of uniform thickness throughout its annular extent. The sealing effectiveness of the flange as a stopper seal is thus materially increased.